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NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON

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NATIONAL DAM SAFETY PROGRAM. CRANES LAKE DAM (NJ 00444). ATLANT--ETC(U)

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ATLANTIC COAST BASIN  
BRANCH OF GREAT EGG HARBOR RIVER  
GLOUCESTER COUNTY, NEW JERSEY

**CRANES LAKE DAM**

**NJ 00444**

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**PHASE 1 INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM**



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**DEPARTMENT OF THE ARMY**

Philadelphia District  
Corps of Engineers  
Philadelphia, Pennsylvania

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| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>This report cites results of a technical investigation as to the dam's adequacy.<br>The inspection and evaluation of the dam is as prescribed by the National Dam<br>Inspection Act, Public Law 92-367. The technical investigation includes visual<br>inspection, review of available design and construction records, and preliminary<br>structural and hydraulic and hydrologic calculations, as applicable. An<br>assessment of the dam's general condition is included in the report. |                                     |  |

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15 JUL 1989

Honorable Brendan T. Byrne  
Governor of New Jersey  
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Cranes Lake Dam in Gloucester County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Cranes Lake Dam, initially listed as a "high" hazard potential structure, but reduced to a "significant" hazard potential structure as a result of this inspection is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 86 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). To ensure adequacy of the structure, the following actions, as a minimum are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within one year from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. Within one year from the date of approval of this report, the following remedial measures should be completed:

(1) The downstream slopes of the embankment should be further protected with seeding and sodding and the sloughed areas refilled.

(2) Provide slope protection to the embankment areas at the rear faces of the downstream wingwalls.

(3) Remove trees on the downstream embankment face.

(4) Rebuild the dam crest near the southwest abutment.

NAPEN-N

Honorable Brendan T. Byrne

(5) The owner should develop an emergency action plan outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam and establish a downstream warning system.

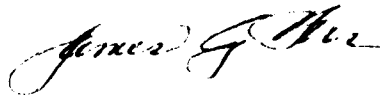
(6) The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Florio of the First District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,



1 Incl  
As stated

JAMES G. TON  
Colonel, Corps of Engineers  
District Engineer

Copies furnished:  
Mr. Dirk C. Hofman, P.E., Deputy Director  
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CRANES LAKE DAM (NJ00444)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 30 November 1979 by Louis Berger and Associates under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Cranes Lake Dam, initially listed as a "high" hazard potential structure, but reduced to a "significant" hazard potential structure as a result of this inspection is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 86 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). To ensure adequacy of the structure, the following actions, as a minimum are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within one year from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. Within one year from the date of approval of this report, the following remedial measures should be completed:

(1) The downstream slopes of the embankment should be further protected with seeding and sodding and the sloughed areas refilled.

(2) Provide slope protection to the embankment areas at the rear faces of the downstream wingwalls.

(3) Remove trees on the downstream embankment face.

(4) Rebuild the dam crest near the southwest abutment.

(5) The owner should develop an emergency action plan outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam and establish a downstream warning system.

(6) The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

APPROVED: *James G. Ton*

JAMES G. TON

Colonel, Corps of Engineers  
District Engineer

DATE: *Dec 1980*

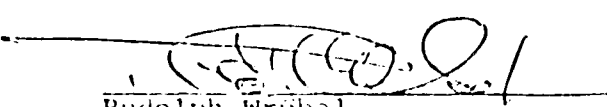
PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Cranes Lake Dam Fed ID# 00444

State Located New Jersey  
County Located Gloucester  
Coordinates Lat. 3937.3 - Long. 7455.7  
Stream Hospitality Branch of Great Egg Harbor River  
Date of Inspection 30 November 1979

ASSESSMENT OF  
GENERAL CONDITIONS

Cranes Lake Dam is assessed to be in an overall structurally good condition except for a portion of unprotected dam crest near the right abutment. It is recommended to be downgraded from a high hazard to a significant hazard category. Overtopping of the dam would not greatly increase the danger of loss of life or property damage as the downstream floodplain is uninhabited. No detrimental findings were revealed to warrant further engineering studies except in view of the spillway capacity, more detailed hydraulic studies are required by Corps of Engineers criteria. Recommended remedial actions to be undertaken in the future as part of a regular maintenance program include 1) rebuild the unprotected dam crest east of the spillway and 2) remove selected trees and dead root systems along the slopes and 3) provide slope protection along the rear faces of the spillway wingwalls. This dam has an inadequate spillway, being able to accommodate 86% of the 0.5 PMF spillway design flood.

  
Rudolph Wrubel  
Vice President  
Louis Berger & Associates, Inc.





OVERVIEW OF CRANES LAKE DAM

November, 1979

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## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM  
NAME OF DAM: CRANES LAKE DAM FED I.D. #NJ 00444

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Corps of Engineers, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Cranes Lake Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Cranes Dam (aka Coles Mill Road Dam) is a 610 foot long curvilinear earth structure with an average crest width of 12 feet and a maximum height of embankment of 11 feet. The embankment is an enlargement of a earlier cranberry bog dike and contains a steel sheeted spillway near the center of the embankment. The three-sided drop inlet is 20 by 25 feet and discharges under a timber bridge on the dam crest and then thru a County owned culvert about 60 feet downstream.

b. Location

Cranes Dam is built across the Hospitality Branch of the Great Egg Harbor River and is approximately

700 feet due south of the intersection of the Black Horse Pike (U.S. Route 322) and Coles Mill Road (Route 538). It is about 2.7 miles west of the intersection point of Camden, Atlantic and Gloucester Counties and is located in the Township of Monroe in the latter county, roughly one half way between the hamlets of Cecil and Berryland on Black Horse Pike.

c. Size Classification

The maximum height of the dam is 11 feet and the maximum storage is estimated to be 319 acre-feet. Therefore the dam is placed in the small size category as defined by the Recommended Guidelines for Safety Inspection of Dams (storage less than 1000 acre-feet and height less than 40 feet).

d. Hazard Classification

Based on the Corps of Engineers criteria and the fact that in the event of a failure, excessive damage could occur to a single downstream property together with the potential for loss of a few lives, the dam is classified as a significant hazard. Although the floodplain is basically undeveloped, immediately downstream there is a house whose elevation is below that of the dam crest. Further, the profile of Coles Mill Road is several feet below the dam crest.

e. Ownership

The dam is owned by Mr. Frank M. Crane, R.D. #4, Box 117 Williamstown, N.J. 08094.

f. Purpose of Dam

The dam impounds an artificial lake which is used solely for recreational purposes.

g. Design and Construction History

Little is known of the dam's early history. Discussions with the owner revealed that the dam was breached in the vicinity of the spillway during hurricane Doria in August 1971. Shortly thereafter plans were prepared to replace an earlier timber spillway with a three-sided steel sheet piling overflow. The specifications and drawings for the

reconstruction work were prepared by Mr. James W. Stingel of the U.S. Department of Agriculture, Soil Conservation Service. The reconstruction was given final approval by the Department of Environmental Protection, Division of Water Resources in April 1973.

h. Normal Operating Procedures

The spillway is operated and maintained by Mr. Frank Crane, owner of the Hospitality Creek Camp Grounds which are situated around the impoundment.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area for Cranes Lake is 14.2 square miles.

b. Discharge at Dam Site

Spillway capacity at maximum pool (top of dam) elevation - 1888 cfs. No discharge records are available at this site.

c. Elevation (Ft. above MSL)

Top of dam (max. pool) - 91.25  
Recreation Pool (spillway crest) - 87  
Streambed of centerline of dam - 80.2

d. Reservoir

Length of maximum pool - 4500 feet  
Length of recreation pool - 1300 feet

e. Storage (acre-feet)

Maximum pool (top of dam) - 319  
Recreation pool - 95

f. Reservoir Surface (acres)

Maximum pool - 105  
Recreation pool - 19

g. Dam

Type - Earth embankment with steel sheet piling  
spillway  
Length - 610 feet  
Width - 12 feet  
Height - 11 feet  
Side Slopes - D/S varies (2 to 1 H:1V); U/S 2H:1V

h. Diversion and Regulating Tunnel - None

i. Spillway

Type: Three-sided narrow crested weir  
Length - 70 feet (effective length - 69.5 feet)  
U/S Channel - main lake reservoir  
D/S Channel - natural stream channel

j. Regulating Outlets

Type - 2 - 3' x 3' ARMCO slide gates

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN

The design information available for review were the 1971-2 construction plans for the spillway (see Figures 2 and 3). The design was undertaken by Mr. James W. Stingel, P.E. Ass't State Conservation Engineer of the U.S. Department of Agriculture. It is unknown to what capacity the steel sheeting was driven but the overall design appears to be quite conservative and follows accepted standard practices. The steel section is U.S. Steel MP 115.

### 2.2 CONSTRUCTION

Nothing is known about the construction except the 1972 work was placed over an earlier cranberry bog embankment which was approximately 4 feet below present crest. The construction is a part of a series of recreation dams along the Hospitality Branch.

### 2.3 OPERATION

Records indicate that the spillway has operated satisfactorily as designed since the 1972 installation.

### 2.4 EVALUATION

#### a. Availability

In view of the size and hazard classification it is felt that sufficient engineering data is available except for the geotechnical composition of the embankment.

#### b. Adequacy

The original plans reveal that the spillway was conservatively designed and from the results of the field inspection, is built in accordance with the design plans.

#### c. Validity

Based on field observations, the validity of the 1972 design plans is not challenged but further investigations would be required in the future to assess the permeability of the embankment and its longterm stability (see section 7).



d. Geotechnical Aspects

This dam is located along the southeastern edge of the recently created reservoir where the general ground surface characteristics are low and undulating and are situated within a wide, shallow, swampy stream area, characteristic of this region. The surficial soils are a combination of recent alluvial deposits, silt and sand, and highly organic layers. Underlying these two soils are the stratified deposits of marine origin, known as the Cohansey Sand, a uniform medium to coarse quartz sand with silty layers commonly interbedded. Due to the low level terrain, the drainage conditions for most of the surrounding area are poor. Depth to bedrock is greater than 100 feet. No boring data was indicated on the design plans.

## SECTION 3 - VISUAL INSPECTIONS

### 3.1 FINDINGS

#### a. General

Visual observations were conducted by the inspection team on November 30, 1979. The reservoir level was several inches above spillway crest and flowing freely. Most of the exposed surface soil and surrounding terrain was in a frozen condition. Near the left end of the embankment there is a bathing area which is surrounded by a submerged wooden baffle which maintains the water surface within the bathing area several inches above the normal recreation crest elevation (the purpose of this is for stabilizing the quality of water within the bathing area on order of the State Department of Health).

#### b. Dam

The embankment is topped by an improved sand and gravel maintenance road and is fairly level and well maintained. As previously stated, it is an enlargement and raising of an earlier cranberry bog dike. The side slopes are, for the most part, uniformly sloped and are covered with a substantial stand of grass. There is some minor erosion and sloughing along the downstream backslopes and several 8 to 12 inch trees in the lower portions of the slope. It was observed that the pavement of Coles Mill Road is slightly below the recreation lake level and acts as a secondary berm in stabilizing the main embankment. Due to the flat terrain, the exact location of the abutment zones is very indefinite. As the soils in this area are predominantly coarse to fine sand with little silt and clay, moderate seepage was observed but because most of the lake (except the bathing area) is between 3 and 5 feet deep, there is little concern regarding this modest infiltration. There is some ponding between the two embankments to the right of the spillway but this is caused in part by a small recreation waterwheel (within the lake) and its small outlet.

c. Appurtenant Structures

The timber bridge and steel sheeting spillway are in satisfactory condition and comply with the design plans prepared by the Soil Conservation Service. The sheeting is driven plumb and properly interlocked. There is minor erosion around the downstream wingwalls which can be easily repaired during the annual maintenance operation. The 10 inch concrete invert slab could not be observed due to the depth of flow but appears level.

d. Reservoir

Crane's Lake has a well-defined shoreline which is heavily wooded with secondary growth except the cleared areas which are used for summer camping and recreational purposes. The lake appears well maintained and clear of debris. The bathing area is spring fed which help maintain its higher water elevation. Upstream from the reservoir, there is a large swampy area before reaching Timber and Victory Lakes, over one mile upstream.

e. Downstream Channel

Hospitality Branch flows unimpeded about 2500 feet southeast after leaving the dam where it passes under Coles Mill Road in a County culvert (No. 9-P-2, built in 1934). This structure has an opening of approximately 5 by 23 feet and appears to be slightly less than adequate for the design storm criteria presented hereinafter. There is one low-lying house to the right of the downstream channel within the probable flood plain. The low water channel is clear and varies between 15 and 25 feet wide and flows southeast 2500 feet into Diamond Lake (NJ 00445), a low hazard category impoundment.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

Operational procedures are conducted by personnel from the owner's maintenance staff. The sluice gates are reportedly operable although they have not been utilized recently. Since the lake is used only for seasonal recreational purposes and the sluice gate capacity is small when compared to the spillway capacity, there is little occasion to attempt to control the lake level by use of the gates.

### 4.2 MAINTENANCE OF DAM

The dam is maintained by the maintenance personnel on an as-needed basis. Informal inspections are conducted after major storms and seasonally as required. A groundskeeper maintains the shoreline and abutment zones adjacent to the spillway.

### 4.3 MAINTENANCE OF OPERATING FACILITIES

The only operating facilities are the two 36" Armco slide gates located in the drop inlet forward wall. These are periodically inspected and maintained but as previously stated, are not employed on a day-to-day basis.

### 4.4 DESCRIPTION OF WARNING SYSTEM

No warning system exists except for monitoring by the owner and his personnel together with municipal police during major storms.

### 4.5 EVALUATION

The existing operational and maintenance procedures and safeguards during major storms are considered adequate for the following reasons:

- 1) The downstream channel apparently experiences high backwater from downstream constrictions which essentially diminishes the dam's function to one of a submerged weir although there are no recent instances of Coles Mill Road being overtopped.

- 2) The owner maintains a close and diligent vigil on the condition of the dam and its day-to-day operation. The primary purpose of the lake and dam preclude any additional operational procedures other than those now in practice. However, in compliance with current Federal directives, the owner should develop an emergency action plan outlining specific actions to be taken by his personnel in case of a severe storm in order to minimize possible downstream hazards.

## SECTION 5 - HYDRAULIC/HYDROLOGIC

### 5.1 EVALUATION OF FEATURES

#### a. Design Data

Based on the criteria in the Recommended Guidelines for Safety Inspection of Dams, Cranes Lake Dam is small in size and is placed in the significant hazard category. Accordingly, one half the probable maximum flood (PMF) was selected as the design storm by the inspecting engineers. Precipitation data was obtained from Hydro-meteorological Report #33. The inflow hydrograph and reservoir routing were calculated utilizing the HEC-1 computer program. The discharge for the SDF was calculated to be 2200 cfs. The maximum spillway capacity is approximately 1888 cfs before overtopping occurs and thus can accommodate 86% of the design flood.

#### b. Experience Data

Records indicate that an earlier timber spillway was washed out in August 1971. There are no reports of serious overtopping or breaches since the reconstruction undertaken immediately thereafter.

#### c. Visual Observation

The owner reports that flow over the weir has never exceeded one foot in recent times. The redesign by the SCS established a design flow of 1100 cfs with a 1.25 foot freeboard. Hence, the maximum overtopping capacity is sufficient to accommodate roughly a 100 year storm.

The spillway and paved apron appear to operate satisfactorily but there is evidence that the downstream County culvert is restricting the discharge and slowly enlarging a natural stilling basin between the dam and roadway embankment. The culvert is partially silted up so its original invert could not be established.

Additionally, it appears that a slightly lower section of the crest (near the right abutment) could possibly function as an auxiliary weir should the flood elevations attain such crest. This was neglected in the appended analysis.

d. Overtopping Potential

Reviewing the design discharge and spillway capacity, the overtopping potential is of minor concern. Due to the poor conditions of the dam crest in the area near the right abutment, breaching could occur at the southwest corner where the crest is roughly one half foot below the average dam crest. The discharge would flow directly into the area of abandoned cranberry bogs and be redirected along the roadway embankment and gradually back to the culvert.

e. Drawdown

Drawdown is provided by the two Armco steel gates at the base of the front spillway wall. Assuming no inflow or tailwater, it would take approximately 25 hours to draw down the reservoir from the normal recreation pool elevation.

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

#### a. Visual observations

Based upon the field inspection of existing conditions and the single source of design plans, the structural stability of the spillway structure is judged to be in a good overall condition but certain sections of the embankment are in need of regrading to be brought up to grade and slope. The spillway foundation and major structural elements are believed to be in a sufficiently integral condition. The depressed condition of the embankment crest near the right abutment and the lower, wooded downstream slopes are of moderate concern to the inspection team, but if remedial action is undertaken within the next few years, these areas will provide satisfactory performance. The modest seepage is of no concern regarding the structural stability. In summary, the dam is in an overall satisfactory condition and is closely monitored by a well-informed owner.

#### b. Design and Construction Data

Although no hydraulic or structural computations were available, the review of the record plans indicate that the steel sheeting spillway and outlet structure were conservatively designed and properly sized.

#### c. Operating Records

No records are available but the dam appears to be operating satisfactorily. There are no known instances of recent overtopping where any serious damage occurred.

#### d. Post Construction Changes

The only post-construction changes have been the replacement of embankment material at various times and the yearly seeding to maintain and protect the sloped surfaces.



e. Seismic Stability

Cranes Lake Dam is located in Zone 1 and due to its low embankment height and spillway geometry, has negligible potential vulnerability regarding earthquake loadings as it is statical stable. Experience indicates that dams in Zone 1 which have adequate factors of safety under static loads will be satisfactory to resist dynamic loadings.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/PROPOSED  
REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, Cranes Lake Dam is classified as being in a good overall structural condition but the spillway is able to pass only 86% of the 0.5 PMF spillway design flood. The dam embankment was built of unknown composition but due to its broad width, compacted crest, grassed slopes and modest likelihood of overtopping, it is felt to be of a sufficient impervious condition to withstand normal hydraulic heads.

b. Adequacy of Information

The information gathered for the Phase I inspection is deemed to be adequate regarding the structural stability of the dam. However, no recent surveys or inspections have been made.

c. Urgency

No immediate urgency is attached hereto and it is recommended that the remedial measures enumerated below be taken under advisement in the future as part of normal maintenance.

d. Necessity for Further Study

Due to the significant hazard classification of the dam, its good overall condition, and the fact that only moderate property damage is foreseen in the event of a failure, further engineering studies are deemed unnecessary except regarding the hydraulics where more concise establishment of the design storm is required by current Federal dam safety criteria.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommended Measures

On the basis of visual inspection and review of the attached hydraulic analyses, improvements to the

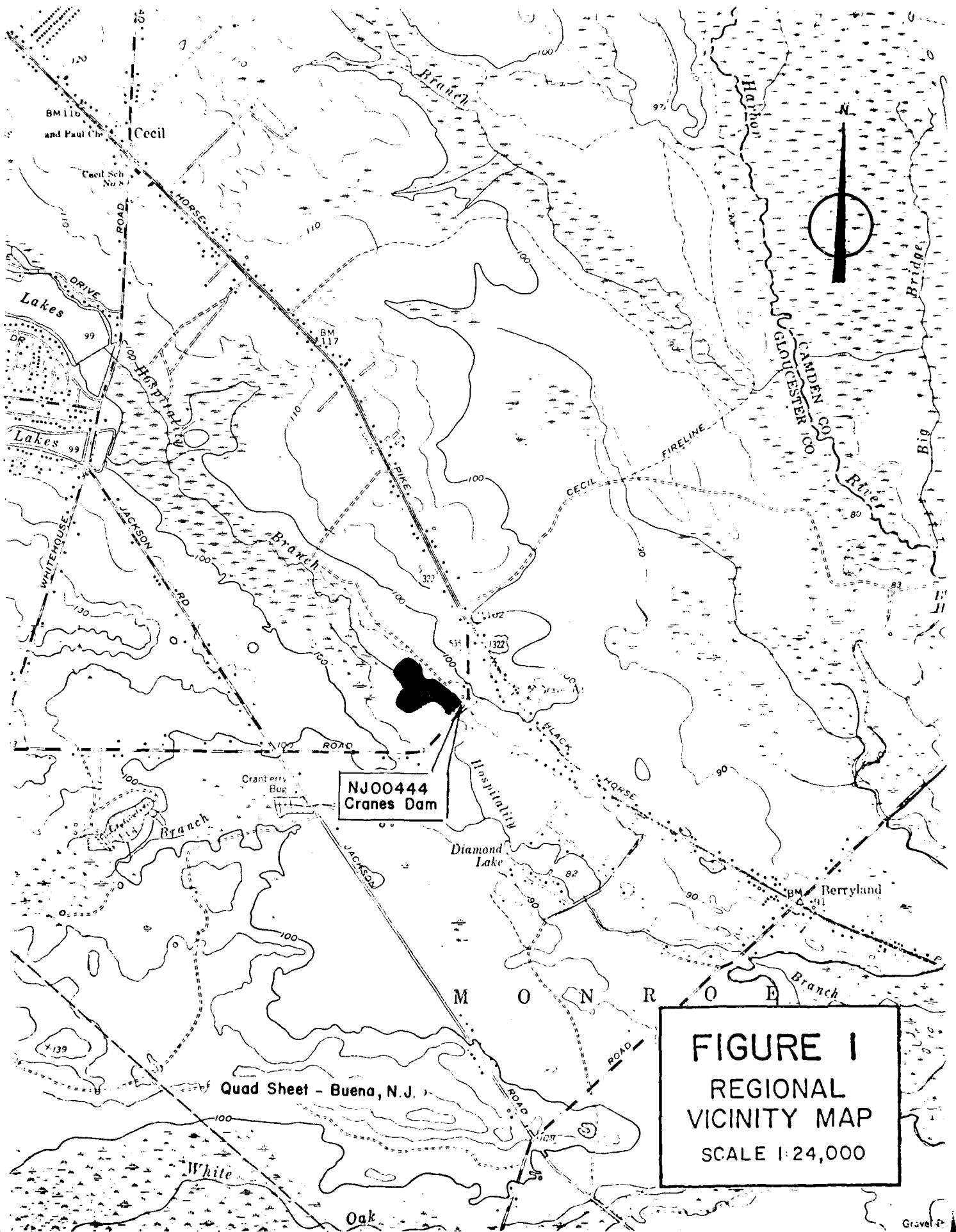
present spillway are not warranted until the hydraulic studies mentioned in the preceding paragraph are completed.

The downstream slopes of the embankment could be further protected with seeding and sodding and the sloughed areas refilled. Remedial measures to be taken under advisement include:

- 1) Provide slope protection to the embankment areas at the rear faces of the downstream wingwalls; and
- 2) Selected removal of the trees on the downstream embankment face;
- 3) Rebuild the dam crest near the southwest abutment.

b. O&M Maintenance and Procedures

In the near future, the owner should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam. See Section 4 for recommendation regarding a warning system.



**FIGURE I**  
**REGIONAL**  
**VICINITY MAP**  
**SCALE 1:24,000**

# CRANE'S LAKE

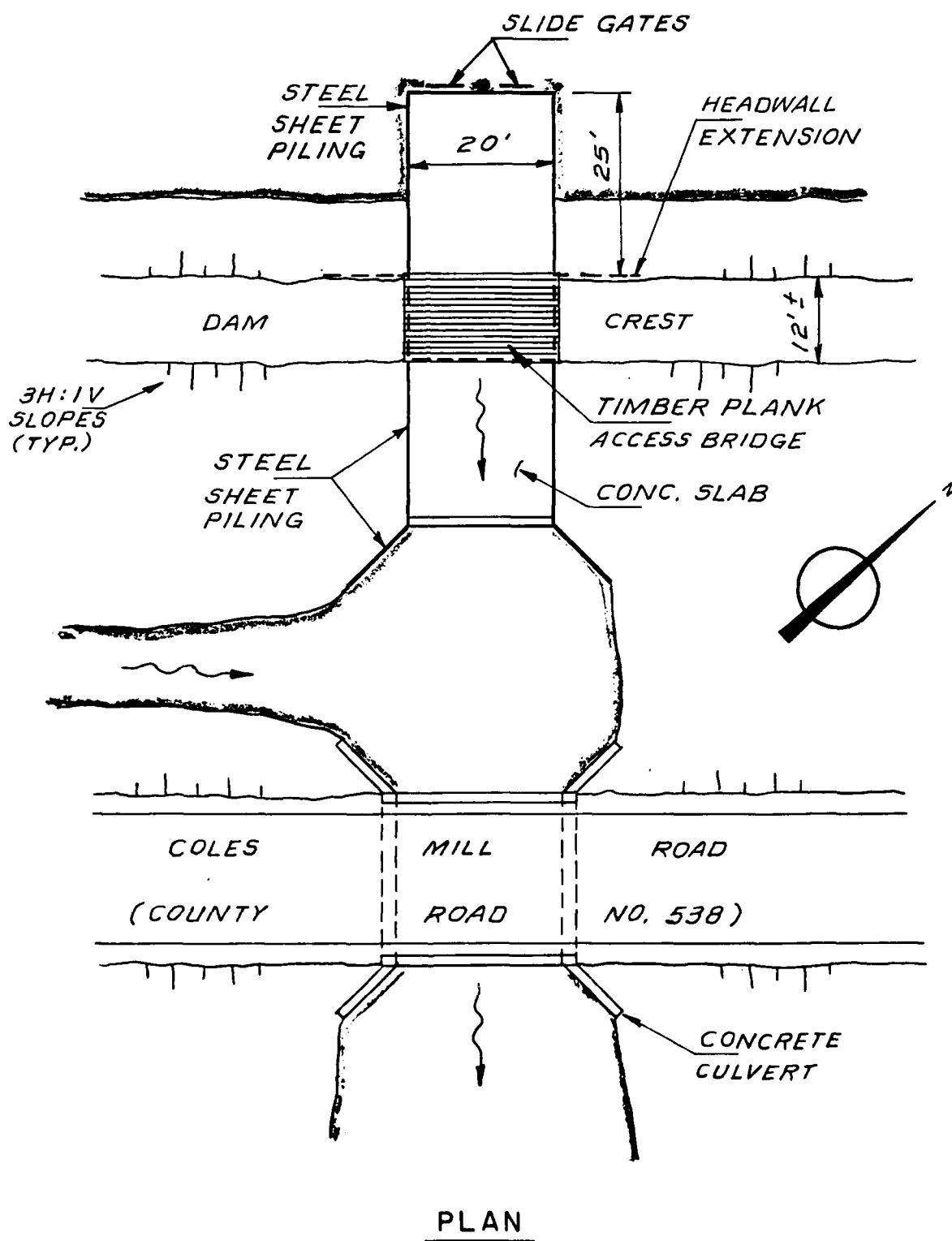


FIGURE 2

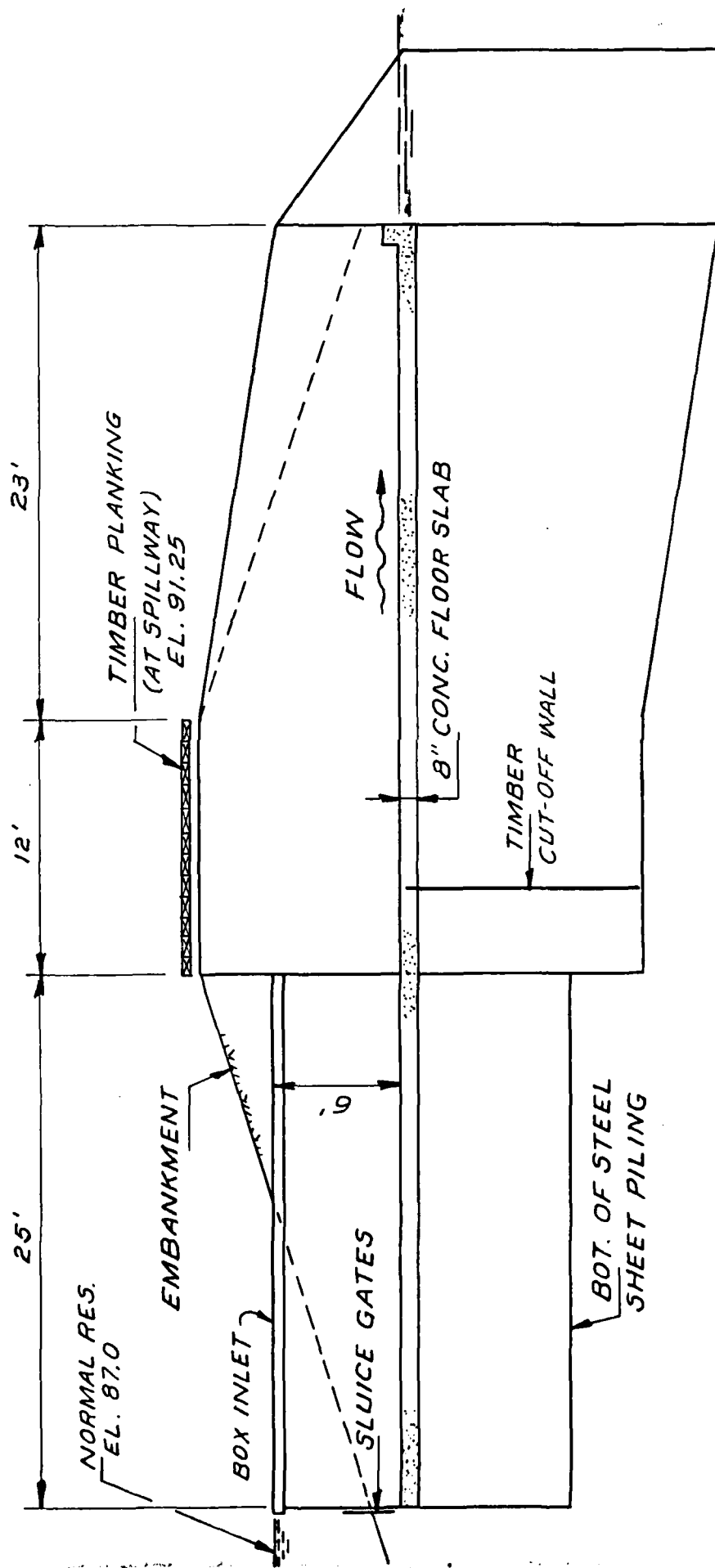


FIGURE 3

SECTION THRU SPILLWAY  
NOT TO SCALE

Check List  
Visual Inspection  
Phase 1

Name Dam CRANES LAKE County BURLINGTON State NEW JERSEY Coordinators NIDEP

Date(s) Inspection 11/30/79 Weather Clear Temperature 35°

Pool Elevation at Time of Inspection 87.2 M.S.L. Tailwater at Time of Inspection 83<sup>+</sup> M.S.L.

Inspection Personnel:

|                  |                 |
|------------------|-----------------|
| <u>R. Lang</u>   | <u>K. Jolls</u> |
| <u>L. Baines</u> | <u>F. Crane</u> |
| <u>M. Carter</u> |                 |

R. Lang Recorder

EMBANKMENT

| VISUAL EXAMINATION OF                                  | OBSERVATIONS   | REMARKS OR RECOMMENDATIONS                            |
|--|--|---|
| SURFACE CRACKS   |  |   |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE      | <p>Steep downstream slopes-generally 1:1, but 1:1.5 in some areas.</p> <p>Upstream slopes grass covered-2H:IV slopes Embankment Flattens out at south end.</p> |   |
| SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES | <p>North end of embankment grassed. Beach area adjacent to spillway. Some surface erosion due to rainfall runoff.</p>  |   |
| VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST         | <p>Good-dirt road along crest, vertical dips toward south about 4-1 foot below top of dam crest. (neglect in H/H calculations).</p>                            | <p>Rebuild the dam crest near southwest abutment.</p> |
| RIPRAP FAILURES  | <p>No riprap</p>   |   |



EMBANKMENT

| VISUAL EXAMINATION OF                                 | OBSERVATIONS  | REMARKS OR RECOMMENDATIONS |
|---|---|----------------------------|
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | Owner states water never over 1 foot above spillway crest.  |                            |
|   | Good, sheet piling walls. High point of road is at spillway bridge. Spillway bridge, timber-one span. Some minor erosion around steel-sheeted wingwalls.                  |                            |
| ANY NOTICEABLE SEEPAGE                                | Much ponding between downstream toe of dam and county road embankment for about 200' south. Some possible seepage, but mostly caused by small water-wheel and its outlet. |                            |
| STAFF GAGE AND RECORDER                               | None  |                            |
| DRAINS  | None  |                            |

OUTLET WORKS

| VISUAL EXAMINATION OF  | OBSERVATIONS                                 | REMARKS OR RECOMMENDATIONS |
|--|--|----------------------------|
| CRACKING AND SPALLING OF<br>CONCRETE SURFACES IN<br>OUTLET CONDUIT | ↑  |                            |
| INTAKE STRUCTURE   |  |                            |
| OUTLET STRUCTURE   |  |                            |
| OUTLET CHANNEL   |  |                            |
| EMERGENCY GATE   | Hand operated lift gate in spillway<br>face. | See record plans.          |

# UNCATED SPILLWAY

| VISUAL EXAMINATION OF | OBSERVATIONS   | REMARKS OR RECOMMENDATIONS |
|-----------------------|--|----------------------------|
| CONCRETE WEIR         | Sheetpiling straight & true.<br>Water flow over approx. 4" deep.   |                            |
| APPROACH CHANNEL      | Lake   | Clear and free of debris.  |
| DISCHARGE CHANNEL     | Small pool 40' + wide downstream of spillway and upstream of county bridge.  |                            |
| BRIDGE AND PIERS      | County Bridge no. 9-p-2<br>Built 1934 William C. Cattell, County Engr. Charles D. Prosser, Contractor<br>60' + below spillway bridge water 3 1/2' below soffit 23 1/2' clear span. |                            |

| GATED SPILLWAY                |  |  | REMARKS OR RECOMMENDATIONS |
|-------------------------------|--|--|----------------------------|
| VISUAL EXAMINATION OF         | OBSERVATIONS   |  |                            |
| CONCRETE SILL                 |  |  |                            |
| APPROACH CHANNEL              | Cranes Lake  |  |                            |
| DISCHARGE CHANNEL             | Apron below spillway   |  |                            |
| BRIDGE AND PIERS              | Timber roadway bridge  |  |                            |
| GATES AND OPERATION EQUIPMENT | Hand operated vertical gate.<br>12" ø pipe feeds waterwheel. |  | Last used Jan. 1979        |

RESERVOIR

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

SLOPES

Low flat heavily wooded area, except  
near beach area.  
Swampy near lake head.

SEDIMENTATION

Minor to south of spillway.

DOWNSTREAM CHANNEL

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

County road elevation lower than water surface  
County Bridge #9-P-2. Stream discharges into  
Diamond Lake (NJ 00445) about 2500' downstream.

Mild, steepening a bit further downstream.

One home immediately below bridge and to the  
south.

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION

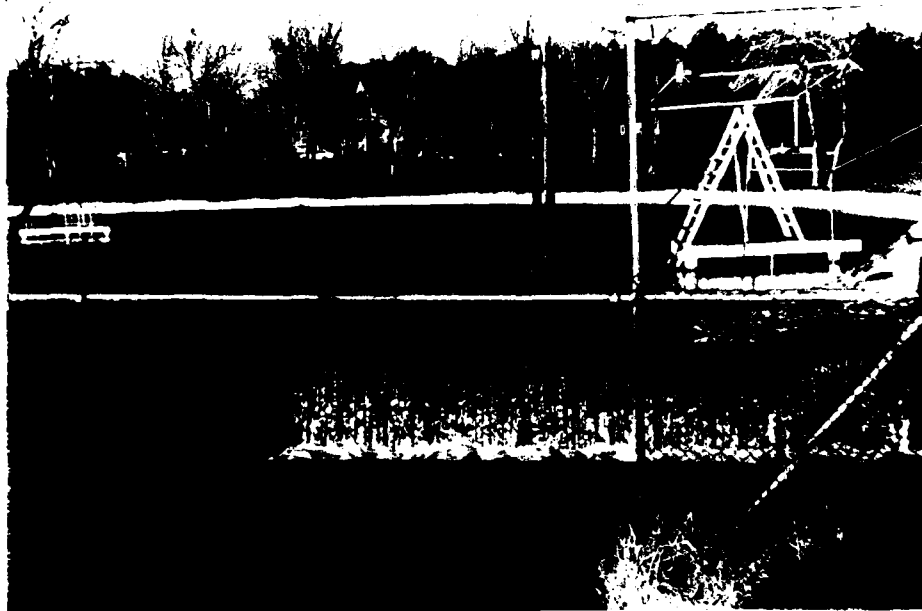
| ITEM                       | REMARKS  |
|----------------------------|--|
| PLAN OF DAM                | Available - NJDEP - Div. of Water Resources -<br>Bureau of Flood Plain Management, Trenton, N.J. |
| REGIONAL VICINITY MAP      | Available - U.S.G.S. Quad - Buena, N.J.  |
| CONSTRUCTION HISTORY       | Some available - 1972 reconstruction (NJDEP)   |
| TYPICAL SECTIONS OF DAM    | Available (NJDEP)  |
| HYDROLOGIC/HYDRAULIC DATA  | Some available-1972 Dam application (NJDEP)  |
| OUTLETS - PLAN             | Available (NJDEP)  |
| - DETAILS                  | Available (NJDEP)  |
| -CONSTRAINTS               | Unknown  |
| -DISTURBANCE RATINGS       | Available (NJDEP)  |
| RAINFALL/RESERV IN RECORDS | None available   |

| ITEM                                   | REMARKS           |
|--|-------------------|
| SPILLWAY PLAN                          | Available (NJDEP) |
| SECTIONS                               | Available (NJDEP) |
| DETAILS                                | Available (NJDEP) |
| OPERATING EQUIPMENT<br>PLANS & DETAILS | None available    |



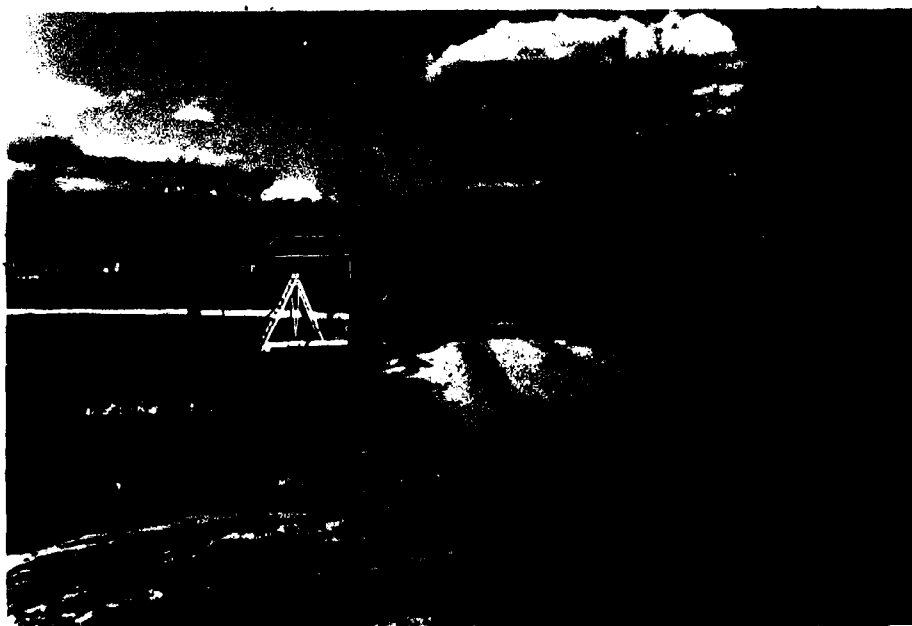
| ITEM                             | REMARKS        |
|----------------------------------|----------------|
| DESIGN REPORTS                   | Not available  |
| GEOLOGY REPORTS                  | None available |
| DESIGN COMPUTATIONS              | Not available  |
| HYDROLOGY & HYDRAULICS           | Not available  |
| DAM STABILITY                    | Not available  |
| SEEPAGE STUDIES                  | Not available  |
| MATERIALS INVESTIGATIONS         | Not available  |
| BORING RECORDS                   | Not available  |
| LABORATORY                       | Not available  |
| FIELD                            | Not available  |
| POST-CONSTRUCTION SURVEYS OF DAM | Not available  |
| BORROW SOURCES                   | Unknown        |

| ITEM  | REMARKS  |
|---|--|
| MONITORING SYSTEMS  | None   |
| MODIFICATIONS   | Some available - 1972 reconstruction (NJDEP)             |
| HIGH POOL RECORDS   | None available   |
| POST CONSTRUCTION ENGINEERING<br>STUDIES AND REPORTS        | Not available  |
| PRIOR ACCIDENTS OR FAILURE OF DAM<br>DESCRIPTION<br>REPORTS | August 1971 breaching.<br>Not available<br>Not available |
| MAINTENANCE<br>OPERATION<br>RECORDS                         | None available   |



November 1979

Steel sheet piling spillway



November 1979

View Northeast along crest



November 1979

Timber bridge & spillway viewed from roadway



November 1979

County roadway culvert, 60' downstream

CHECK LIST  
HYDROLOGIC AND HYDRAULIC DATA  
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Drainage Area = 14.2 square mile

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): +87.0 M.S.L. (95 acre-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not Applicable

ELEVATION MAXIMUM DESIGN POOL: \_\_\_\_\_

ELEVATION TOP DAM: +91.25 M.S.L. (319 acre-feet)

CREST: \_\_\_\_\_

- a. Elevation \_\_\_\_\_
- b. Type Earth embankment with steel sheet piling spillway
- c. Width Varies (8'-20')
- d. Length 610'
- e. Location Spillover 150' from left abutment
- f. Number and Type of Gates 2-3'x3' Armco Slide Gates

OUTLET WORKS: \_\_\_\_\_

- a. Type Steel sheeting narrow crested weir
- b. Location 150' from left abutment
- c. Entrance inverts +87.0 M.S.L.
- d. Exit inverts +81.75 M.S.L.
- e. Emergency draindown facilities 2-3'x3' Armco Slide Gates

HYDROMETEOROLOGICAL GAGES: None

- a. Type \_\_\_\_\_
- b. Location \_\_\_\_\_
- c. Records \_\_\_\_\_

MAXIMUM NON-DAMAGING DISCHARGE: 1888 cfs

BY RFB DATE 1-21-60 LOUIS BERGER & ASSOCIATES INC.  
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_ CRANK LAKE DAM  
SUBJECT \_\_\_\_\_

SHEET NO. A1 OF \_\_\_\_\_  
PROJECT C-246

### UNIT GRAPH DATA

LENGTH OF LONGEST WATERCOURSE

$$L = 7.77 \text{ MI}$$

LENGTH TO CENTROID

$$L_c = 3.03 \text{ MI}$$

$$LL_c = 7.77 \times 3.03 = 23.54$$

USING CURVE 1 FROM COE PLATE 17 FROM SPECIAL  
PROJECT MEMO 459;  $t_p = 29.5$

USE SNYDER COEFFICIENT FURNISHED BY COE

$$\therefore C_p = 0.60$$

---

### PRECIPITATION

PMF FOR 200 SQ MI & 24 HOUR DURATION = 24"

MAXIMUM 6 HOUR PERCENTAGE = 110%

MAXIMUM 12 HOUR PERCENTAGE = 120%

MAXIMUM 24 HOUR PERCENTAGE = 129%

MAXIMUM 48 HOUR PERCENTAGE = 140%

BY RJE DATE 1-21-90

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A2 OF

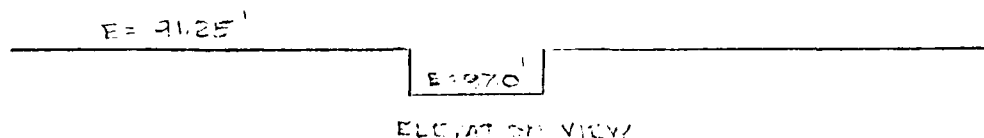
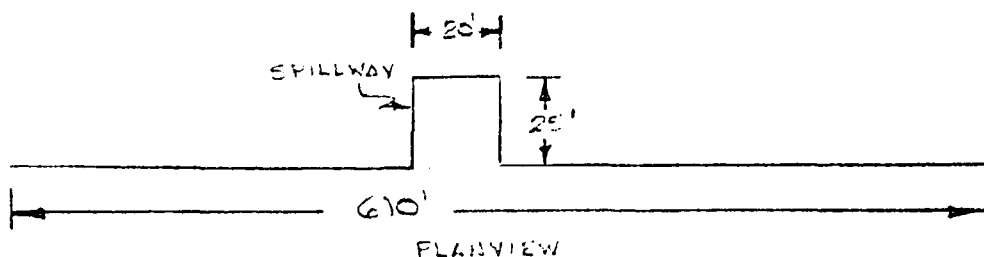
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

Charles L. C. Dam

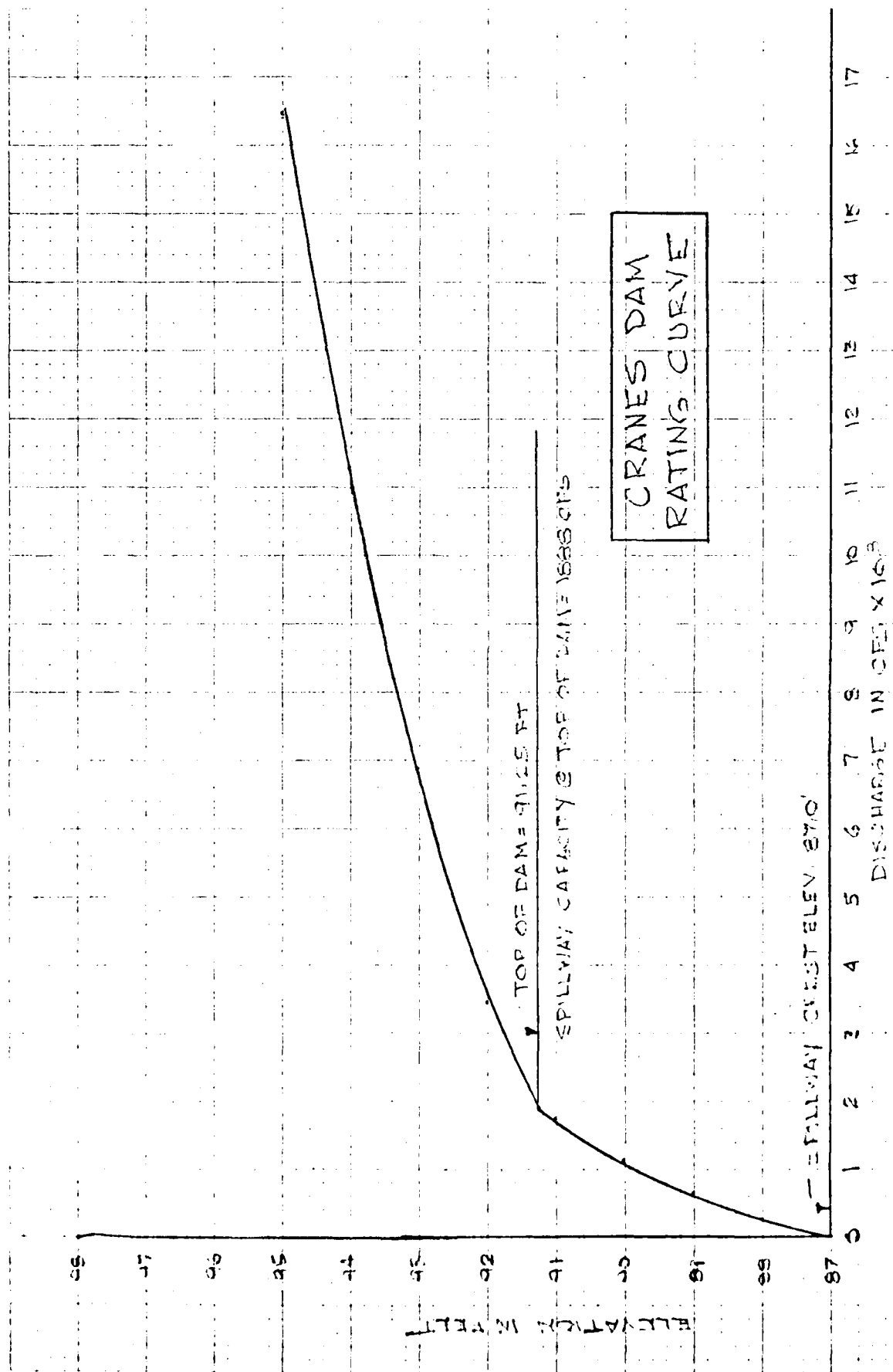
PROJECT C-241

SUBJECT \_\_\_\_\_

SPILLWAY CAVESITY



| ELEV  | SPILLWAY |     |      |      | EMBANKMENT |     |      |       | Σ     |
|-------|----------|-----|------|------|------------|-----|------|-------|-------|
|       | H        | C   | L    | G    | H          | C   | L    | G     |       |
| 87    | 0        | 3.1 | 69.5 | 0    | 0          | 2.7 | 59.0 | 0     | 0     |
| 88    | 1        |     |      | 215  | 0          |     |      | 0     | 215   |
| 89    | 2        |     |      | 609  | 0          |     |      | 0     | 609   |
| 90    | 3        |     |      | 1120 | 0          |     |      | 0     | 1120  |
| 91    | 4        |     |      | 1724 | 0          |     |      | 0     | 1724  |
| 91.25 | 4.25     |     |      | 1868 | 0          |     |      | 0     | 1868  |
| 92    | 5        |     |      | 2404 | .75        |     |      | 1055  | 3454  |
| 93    | 6        |     |      | 3126 | 1.75       |     |      | 3686  | 6354  |
| 94    | 7        |     |      | 3990 | 2.75       |     |      | 7265  | 11255 |
| 95    | 8        |     |      | 4875 | 3.75       |     |      | 11524 | 16444 |





BY RFE DATE 1-21-80

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A4 OF

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

CRANE DAM

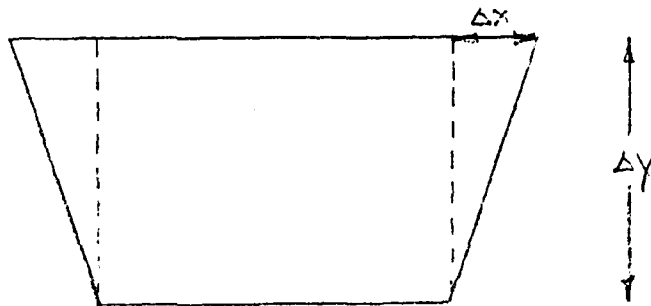
PROJECT \_\_\_\_\_

SUBJECT \_\_\_\_\_

AREA OF LAKE @ ELEV. 87.0 = 19 ACRES

AREA OF POOL @ 90 FT CONTOUR = 66.6 ACRES

ASSUME POOL AREA ABOVE 90 FT CONTOUR PROJECTS  
AT SAME RATE.



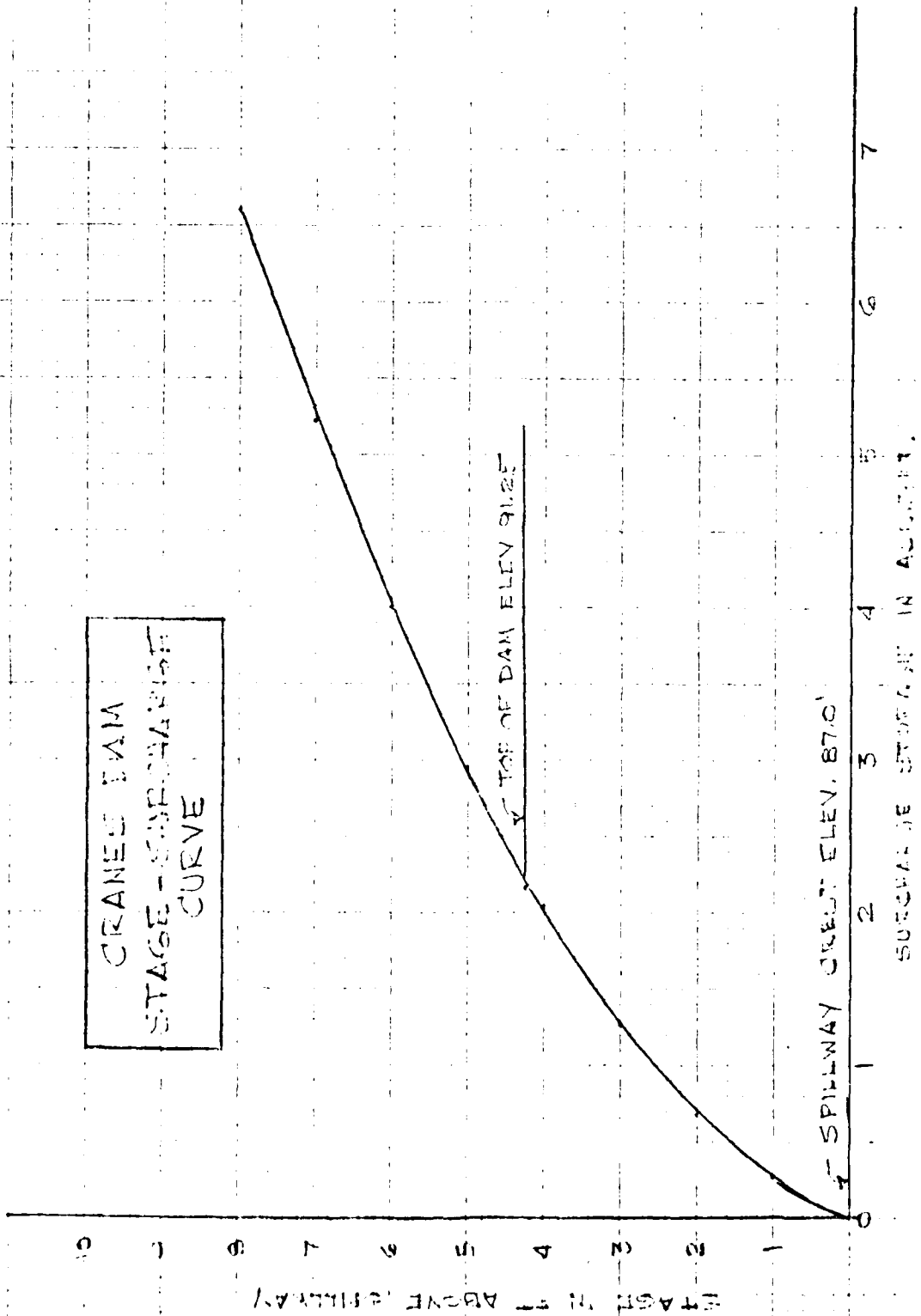
$$\Delta Y = \Delta Y (X + \Delta X)$$

| HEIGHT ABOVE<br>SPILLWAY CREST | A<br>ACRES | Δ<br>VOL | SEARCHED-SPILLING<br>ACFT-H |
|--------------------------------|------------|----------|-----------------------------|
| 0                              | 19.0       | 0        | 0                           |
| 1                              | 34.9       | 26.9     | 27                          |
| 2                              | 50.7       | 43.8     | 68                          |
| 3                              | 66.6       | 58.6     | 126                         |
| 4                              | 82.5       | 74.6     | 202                         |
| 4.25                           | 88.4       | 81.1     | 234                         |
| 5                              | 98.2       | 61.8     | 296                         |
| 6                              | 114.2      | 106.2    | 402                         |
| 7                              | 120.0      | 120.1    | 522                         |
| 8                              | 142.9      | 128.0    | 660                         |

J-246

AE

CRANES DAM  
STAGE - SURGE CURVE



BY L.B. DATE 1-52

LOUIS BERGER & ASSOCIATES INC.

SHEET NO A6 OF

CHKD. BY DATE

CRANES DAM

PROJECT C-244

SUBJECT APPROXIMATE DRAWDOWN CALCULATIONS

AVAILABLE HEAD = 5.25'

STORAGE AT NORMAL POOL = 95 acre-feet

ASSUME DRAWDOWN IN 2 STAGES WITH NO INFLOW  
AND NO TAILWATER

ASSUME DRAWDOWN IS ACCOMPLISHED USING THE  
2 - 3'x3' ARMO SLIDE GATES

STAGE 1)

$$H = 2.44 \text{ ft}$$

$$Q = CA\sqrt{2gH}$$

$$C = 0.5 \quad A = 18 \text{ ft}^2$$

$$= 0.5(18)\sqrt{64.4 \times 2.44}$$

$$= 113 \text{ cfs}$$

$$\text{Time} = \frac{95 \times 43560}{2 \times 113 \times 3600}$$

$$= 5 \text{ hrs}$$

STAGE 2)

$$H = 1.31 \text{ ft}$$

$$Q = CLH^{3/2} = 3.1(3)(1.31)^{3/2}$$

$$C = 3.1 \quad L = 2(3) = 6$$

$$= 28 \text{ cfs}$$

$$\text{Time} = \frac{95(43560)}{2 \times 28 \times 3600}$$

$$= 20 \text{ hrs}$$

$$\Sigma \text{Time} = 5 + 20 = 25 \text{ hrs}$$

# A CRANES DAM

A CRANES DAM  
A BY R F BERRY  
A APRIL 1920

U 150  
I 1 2

I INFLOW HYDROGRAPH

M 1 14.2 0 14.2  
P 0 24 110 120 129 140

0.5 0.1

M 29.5 0.5

X 0 0

K 1 11

ROUTING THROUGH RESERVOIR

Y 1

2 0 27

3 0 21.5

K 0 99

A 0

A 0

A 0

A 0

A 0

1

0.5

0.5

1

293 400 522 660

344 6854 11255 16444

224

1889

203

1724

128

1120

68

609

\*\*\*\*\*  
 HEC-1 VERSION DATED JAN 1973  
 UPDATED AUG 74  
 CHANGE NO 01  
 \*\*\*\*\*

GRANDES DAM  
 BY R. F. BERRY  
 APRIL 1980

JOB SPECIFICATION  
 NG NHR NMIN IDAY IHR IMIN MEIRC IPLT IPRT NSTAN  
 150 2 0 0 0 0 0 0 0  
 JOPER 0 NWT  
 3 0

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH  
 ISTAQ 1

IECON 0 ITAPE 0 JPLT 0 JPART INAME 1

HYDROGRAPH DATA

| IHYG | IUNG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|------|------|-------|------|-------|-------|-------|-------|-------|-------|
| 1    | 1    | 14.20 | 0.00 | 14.20 | 0.00  | 0.500 | 0     | 0     | 0     |

PRECIP DATA

| SFPE | PMS   | R6     | R12    | R24    | R48    | R72  | R96  |
|------|-------|--------|--------|--------|--------|------|------|
| 0.00 | 24.00 | 110.00 | 120.00 | 129.00 | 140.00 | 0.00 | 0.00 |

THSPC COMPUTED BY THE PROGRAM IS 0.812

LOSS DATA

| STPKR | DLTKR | RTIOL | ERAIN | STKRS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.00  | 0.00  | 1.00  | 0.00  | 0.00  | 1.00  | 0.50  | 0.10  | 0.00  | 0.00  |

UNIT HYDROGRAPH DATA

TP= 29.50 CP=0.60 NTA= 0

RECESSION DATA

STRTQ= 0.00 GRCSN= 0.00 RTIOR= 1.00  
 APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=16.05 AND R=14.84 INTERVALS

| UNIT | HYDROGRAPH | 93  | END-OF-PERIOD | ORDINATES | LAG= | 29.38 | HOURS | CP= | 0.60 | VOL= | 1.00 |
|------|------------|-----|---------------|-----------|------|-------|-------|-----|------|------|------|
| 2    | 12         | 29  | 41            | 58        | 76   | 95    | 115   | 134 | 152  |      |      |
| 128  | 177        | 185 | 191           | 192       | 189  | 180   | 169   | 158 | 147  |      |      |
| 128  | 129        | 120 | 113           | 105       | 98   | 92    | 86    | 80  | 75   |      |      |
| 20   | 66         | 61  | 57            | 54        | 50   | 47    | 44    | 41  | 38   |      |      |
| 25   | 33         | 31  | 29            | 27        | 25   | 24    | 22    | 21  | 20   |      |      |
| 15   | 17         | 16  | 15            | 14        | 13   | 12    | 11    | 11  | 10   |      |      |
| 7    | 9          | 8   | 7             | 7         | 7    | 6     | 6     | 5   | 5    |      |      |
| 5    | 4          | 4   | 4             | 4         | 3    | 3     | 3     | 3   | 3    |      |      |

A-9

| TIME | END-OF-PERIOD FLOW |       |    |    | COMP Q |
|------|--------------------|-------|----|----|--------|
|      | RAIN               | EXCS  | 2. | 2. |        |
| 1    | 0.02               | 0.00  | 2. | 2. | 0.     |
| 2    | 0.02               | 0.00  |    |    | 0.     |
| 3    | 0.02               | 0.00  |    |    | 0.     |
| 4    | 0.05               | 0.00  |    |    | 0.     |
| 5    | 0.05               | 0.00  |    |    | 0.     |
| 6    | 0.05               | 0.00  |    |    | 0.     |
| 7    | 0.43               | 0.12  |    |    | 0.     |
| 8    | 0.97               | 0.77  |    |    | 4.     |
| 9    | 0.38               | 0.18  |    |    | 13.    |
| 10   | 0.03               | 0.00  |    |    | 25.    |
| 11   | 0.03               | 0.00  |    |    | 43.    |
| 12   | 0.03               | 0.00  |    |    | 61.    |
| 13   | 0.23               | 0.03  |    |    | 80.    |
| 14   | 0.23               | 0.03  |    |    | 101.   |
| 15   | 0.23               | 0.03  |    |    | 123.   |
| 16   | 0.65               | 0.45  |    |    | 145.   |
| 17   | 0.65               | 0.45  |    |    | 172.   |
| 18   | 0.65               | 0.45  |    |    | 200.   |
| 19   | 5.57               | 5.37  |    |    | 249.   |
| 20   | 11.36              | 11.16 |    |    | 365.   |
| 21   | 4.50               | 4.30  |    |    | 581.   |
| 22   | 0.35               | 0.15  |    |    | 875.   |
| 23   | 0.35               | 0.15  |    |    | 1220.  |
| 24   | 0.35               | 0.15  |    |    | 1576.  |
| 25   | 0.00               | 0.00  |    |    | 1996.  |
| 26   | 0.00               | 0.00  |    |    | 2413.  |
| 27   | 0.00               | 0.00  |    |    | 2833.  |
| 28   | 0.00               | 0.00  |    |    | 3248.  |
| 29   | 0.00               | 0.00  |    |    | 3612.  |
| 30   | 0.00               | 0.00  |    |    | 3913.  |
| 31   | 0.00               | 0.00  |    |    | 4145.  |
| 32   | 0.00               | 0.00  |    |    | 4306.  |
| 33   | 0.00               | 0.00  |    |    | 4393.  |
| 34   | 0.00               | 0.00  |    |    | 4400.  |
| 35   | 0.00               | 0.00  |    |    | 4308.  |
| 36   | 0.00               | 0.00  |    |    | 4117.  |
| 37   | 0.00               | 0.00  |    |    | 3870.  |
| 38   | 0.00               | 0.00  |    |    | 3622.  |
| 39   | 0.00               | 0.00  |    |    | 3338.  |
| 40   | 0.00               | 0.00  |    |    | 3168.  |
| 41   | 0.00               | 0.00  |    |    | 2961.  |
| 42   | 0.00               | 0.00  |    |    | 2768.  |
| 43   | 0.00               | 0.00  |    |    | 2583.  |
| 44   | 0.00               | 0.00  |    |    | 2419.  |
| 45   | 0.00               | 0.00  |    |    | 2262.  |
| 46   | 0.00               | 0.00  |    |    | 2114.  |
| 47   | 0.00               | 0.00  |    |    | 1977.  |
| 48   | 0.00               | 0.00  |    |    | 1848.  |
| 49   | 0.00               | 0.00  |    |    | 1727.  |
| 50   | 0.00               | 0.00  |    |    | 1615.  |
| 51   | 0.00               | 0.00  |    |    | 1510.  |

A-10

|     |      |      |      |
|-----|------|------|------|
| 52  | 0.00 | 0.00 | 1411 |
| 53  | 0.00 | 0.00 | 1319 |
| 54  | 0.00 | 0.00 | 1233 |
| 55  | 0.00 | 0.00 | 1153 |
| 56  | 0.00 | 0.00 | 1078 |
| 57  | 0.00 | 0.00 | 1007 |
| 58  | 0.00 | 0.00 | 942  |
| 59  | 0.00 | 0.00 | 880  |
| 60  | 0.00 | 0.00 | 823  |
| 61  | 0.00 | 0.00 | 759  |
| 62  | 0.00 | 0.00 | 715  |
| 63  | 0.00 | 0.00 | 672  |
| 64  | 0.00 | 0.00 | 629  |
| 65  | 0.00 | 0.00 | 588  |
| 66  | 0.00 | 0.00 | 549  |
| 67  | 0.00 | 0.00 | 514  |
| 68  | 0.00 | 0.00 | 480  |
| 69  | 0.00 | 0.00 | 445  |
| 70  | 0.00 | 0.00 | 420  |
| 71  | 0.00 | 0.00 | 392  |
| 72  | 0.00 | 0.00 | 367  |
| 73  | 0.00 | 0.00 | 343  |
| 74  | 0.00 | 0.00 | 320  |
| 75  | 0.00 | 0.00 | 300  |
| 76  | 0.00 | 0.00 | 280  |
| 77  | 0.00 | 0.00 | 262  |
| 78  | 0.00 | 0.00 | 245  |
| 79  | 0.00 | 0.00 | 229  |
| 80  | 0.00 | 0.00 | 214  |
| 81  | 0.00 | 0.00 | 200  |
| 82  | 0.00 | 0.00 | 187  |
| 83  | 0.00 | 0.00 | 175  |
| 84  | 0.00 | 0.00 | 163  |
| 85  | 0.00 | 0.00 | 153  |
| 86  | 0.00 | 0.00 | 143  |
| 87  | 0.00 | 0.00 | 133  |
| 88  | 0.00 | 0.00 | 125  |
| 89  | 0.00 | 0.00 | 117  |
| 90  | 0.00 | 0.00 | 109  |
| 91  | 0.00 | 0.00 | 102  |
| 92  | 0.00 | 0.00 | 95   |
| 93  | 0.00 | 0.00 | 88   |
| 94  | 0.00 | 0.00 | 83   |
| 95  | 0.00 | 0.00 | 78   |
| 96  | 0.00 | 0.00 | 72   |
| 97  | 0.00 | 0.00 | 67   |
| 98  | 0.00 | 0.00 | 62   |
| 99  | 0.00 | 0.00 | 56   |
| 100 | 0.00 | 0.00 | 51   |
| 101 | 0.00 | 0.00 | 47   |
| 102 | 0.00 | 0.00 | 44   |
| 103 | 0.00 | 0.00 | 41   |
| 104 | 0.00 | 0.00 | 37   |
| 105 | 0.00 | 0.00 | 34   |

A-11

|     |       |       |        |    |
|-----|-------|-------|--------|----|
| 107 | 0.00  | 0.00  | 0.00   | 25 |
| 108 | 0.00  | 0.00  | 0.00   | 7  |
| 109 | 0.00  | 0.00  | 0.00   | 1  |
| 110 | 0.00  | 0.00  | 0.00   | 0  |
| 111 | 0.00  | 0.00  | 0.00   | 0  |
| 112 | 0.00  | 0.00  | 0.00   | 0  |
| 113 | 0.00  | 0.00  | 0.00   | 0  |
| 114 | 0.00  | 0.00  | 0.00   | 0  |
| 115 | 0.00  | 0.00  | 0.00   | 0  |
| 116 | 0.00  | 0.00  | 0.00   | 0  |
| 117 | 0.00  | 0.00  | 0.00   | 0  |
| 118 | 0.00  | 0.00  | 0.00   | 0  |
| 119 | 0.00  | 0.00  | 0.00   | 0  |
| 120 | 0.00  | 0.00  | 0.00   | 0  |
| 121 | 0.00  | 0.00  | 0.00   | 0  |
| 122 | 0.00  | 0.00  | 0.00   | 0  |
| 123 | 0.00  | 0.00  | 0.00   | 0  |
| 124 | 0.00  | 0.00  | 0.00   | 0  |
| 125 | 0.00  | 0.00  | 0.00   | 0  |
| 126 | 0.00  | 0.00  | 0.00   | 0  |
| 127 | 0.00  | 0.00  | 0.00   | 0  |
| 128 | 0.00  | 0.00  | 0.00   | 0  |
| 129 | 0.00  | 0.00  | 0.00   | 0  |
| 130 | 0.00  | 0.00  | 0.00   | 0  |
| 131 | 0.00  | 0.00  | 0.00   | 0  |
| 132 | 0.00  | 0.00  | 0.00   | 0  |
| 133 | 0.00  | 0.00  | 0.00   | 0  |
| 134 | 0.00  | 0.00  | 0.00   | 0  |
| 135 | 0.00  | 0.00  | 0.00   | 0  |
| 136 | 0.00  | 0.00  | 0.00   | 0  |
| 137 | 0.00  | 0.00  | 0.00   | 0  |
| 138 | 0.00  | 0.00  | 0.00   | 0  |
| 139 | 0.00  | 0.00  | 0.00   | 0  |
| 140 | 0.00  | 0.00  | 0.00   | 0  |
| 141 | 0.00  | 0.00  | 0.00   | 0  |
| 142 | 0.00  | 0.00  | 0.00   | 0  |
| 143 | 0.00  | 0.00  | 0.00   | 0  |
| 144 | 0.00  | 0.00  | 0.00   | 0  |
| 145 | 0.00  | 0.00  | 0.00   | 0  |
| 146 | 0.00  | 0.00  | 0.00   | 0  |
| 147 | 0.00  | 0.00  | 0.00   | 0  |
| 148 | 0.00  | 0.00  | 0.00   | 0  |
| 149 | 0.00  | 0.00  | 0.00   | 0  |
| 150 | 0.00  | 0.00  | 0.00   | 0  |
| SUM | 27.28 | 23.79 | 106921 |    |

TOTAL VOLUME  
106920  
23.70  
17446

6-HOUR 24-HOUR 72-HOUR  
4367 3943 2569  
2.86 10.33 20.20  
2157 7226 15295

RUNOFF MULTIPLIED BY 0.50

0.00 0.00 0.00  
50 61 73

0 2. 7. 13  
66 100 124 183



|     |     |      |      |      |      |      |      |      |      |
|-----|-----|------|------|------|------|------|------|------|------|
| 200 | 409 | 610  | 798  | 978  | 1207 | 1419 | 1624 | 1806 | 1956 |
| 202 | 213 | 2197 | 2200 | 2154 | 2058 | 1935 | 1811 | 1694 | 1594 |
| 100 | 100 | 1294 | 1210 | 1131 | 1057 | 988  | 924  | 864  | 807  |
| 100 | 100 | 100  | 417  | 576  | 529  | 504  | 471  | 440  | 412  |
| 100 | 100 | 328  | 314  | 294  | 275  | 257  | 240  | 224  | 210  |
| 100 | 100 | 171  | 150  | 150  | 140  | 131  | 122  | 114  | 107  |
| 100 | 93  | 87   | 82   | 76   | 71   | 67   | 62   | 58   | 55   |
| 51  | 45  | 43   | 42   | 39   | 35   | 33   | 31   | 29   | 27   |
| 25  | 24  | 22   | 20   | 19   | 17   | 12   | 4    | 0    | 0    |
| 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

PEAK  
2200  
CFS  
1.43  
INCHES  
1083  
AC-FT

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## HYDROGRAPH ROUTING

## ROUTING THROUGH RESERVOIR

ROUTING DATA  
IECON ITAPE JPLT JPRT INAME  
0 0 0 0 1  
ROUTING DATA  
CLOSS AVG IFES ISAME  
0.0 0.00 1 0  
NSTPS NSTDL LAG ANSKK X TSK STORA  
1 0 0 0.000 0.000 0.000 0

STORAGE= 0 27 68 128 203 224 293 400 522 660  
OUTFLOW= 0 215 609 1120 1724 1868 3444 6894 11255 16444

TIME EOP STOR AVG IN EOP OUT  
1 0 0 0 0  
2 0 0 0 0  
3 0 0 0 0  
4 0 0 0 0  
5 0 0 0 0  
6 0 0 0 0  
7 0 0 0 0  
8 0 0 0 0  
9 0 0 0 0  
10 1 10 4 9  
11 2 17 15 15  
12 3 26 24 24  
13 4 35 33 33  
14 5 45 43 43  
15 7 56 53 53  
16 8 67 64 64

|    |     |      |      |
|----|-----|------|------|
| 17 | 10  | 80   | 76   |
| 18 | 11  | 93   | 90   |
| 19 | 14  | 112  | 108  |
| 20 | 19  | 154  | 144  |
| 21 | 27  | 237  | 218  |
| 22 | 41  | 354  | 347  |
| 23 | 57  | 524  | 504  |
| 24 | 76  | 704  | 676  |
| 25 | 97  | 898  | 859  |
| 26 | 121 | 1102 | 1060 |
| 27 | 146 | 1313 | 1254 |
| 28 | 171 | 1521 | 1470 |
| 29 | 196 | 1715 | 1662 |
| 30 | 217 | 1881 | 1836 |
| 31 | 230 | 2014 | 2034 |
| 32 | 239 | 2113 | 2137 |
| 33 | 247 | 2175 | 2195 |
| 34 | 256 | 2192 | 2202 |
| 35 | 266 | 2177 | 2170 |
| 36 | 272 | 2106 | 2087 |
| 37 | 278 | 1997 | 1959 |
| 38 | 281 | 1873 | 1862 |
| 39 | 210 | 1753 | 1775 |
| 40 | 196 | 1539 | 1567 |
| 41 | 182 | 1532 | 1559 |
| 42 | 170 | 1432 | 1458 |
| 43 | 158 | 1339 | 1363 |
| 44 | 147 | 1252 | 1274 |
| 45 | 137 | 1170 | 1191 |
| 46 | 127 | 1094 | 1113 |
| 47 | 118 | 1023 | 1038 |
| 48 | 110 | 955  | 970  |
| 49 | 103 | 894  | 907  |
| 50 | 96  | 836  | 848  |
| 51 | 90  | 781  | 793  |
| 52 | 84  | 730  | 741  |
| 53 | 78  | 683  | 693  |
| 54 | 73  | 638  | 648  |
| 55 | 68  | 597  | 605  |
| 56 | 63  | 558  | 563  |
| 57 | 59  | 521  | 526  |
| 58 | 55  | 487  | 492  |
| 59 | 52  | 456  | 460  |
| 60 | 49  | 425  | 430  |
| 61 | 46  | 398  | 402  |
| 62 | 44  | 372  | 376  |
| 63 | 41  | 349  | 351  |
| 64 | 39  | 325  | 328  |
| 65 | 37  | 304  | 307  |
| 66 | 34  | 284  | 287  |
| 67 | 31  | 266  | 268  |
| 68 | 29  | 249  | 251  |
| 69 | 27  | 232  | 234  |
| 70 | 27  | 217  | 219  |
| 71 | 24  | 203  | 206  |

|     |      |      |
|-----|------|------|
| 72  | 190. | 193. |
| 73  | 177. | 181. |
| 74  | 166. | 169. |
| 75  | 155. | 158. |
| 76  | 145. | 148. |
| 77  | 135. | 138. |
| 78  | 127. | 139. |
| 79  | 118. | 121. |
| 80  | 111. | 113. |
| 81  | 103. | 105. |
| 82  | 97.  | 98.  |
| 83  | 90.  | 92.  |
| 84  | 85.  | 86.  |
| 85  | 79.  | 80.  |
| 86  | 74.  | 75.  |
| 87  | 69.  | 70.  |
| 88  | 65.  | 66.  |
| 89  | 60.  | 61.  |
| 90  | 56.  | 57.  |
| 91  | 53.  | 54.  |
| 92  | 49.  | 50.  |
| 93  | 46.  | 47.  |
| 94  | 43.  | 44.  |
| 95  | 40.  | 41.  |
| 96  | 37.  | 38.  |
| 97  | 35.  | 36.  |
| 98  | 32.  | 33.  |
| 99  | 30.  | 31.  |
| 100 | 28.  | 29.  |
| 101 | 26.  | 27.  |
| 102 | 25.  | 26.  |
| 103 | 23.  | 23.  |
| 104 | 21.  | 22.  |
| 105 | 20.  | 20.  |
| 106 | 18.  | 18.  |
| 107 | 15.  | 16.  |
| 108 | 8.   | 10.  |
| 109 | 2.   | 4.   |
| 110 | 0.   | 1.   |
| 111 | 0.   | 0.   |
| 112 | 0.   | 0.   |
| 113 | 0.   | 0.   |
| 114 | 0.   | 0.   |
| 115 | 0.   | 0.   |
| 116 | 0.   | 0.   |
| 117 | 0.   | 0.   |
| 118 | 0.   | 0.   |
| 119 | 0.   | 0.   |
| 120 | 0.   | 0.   |
| 121 | 0.   | 0.   |
| 122 | 0.   | 0.   |
| 123 | 0.   | 0.   |
| 124 | 0.   | 0.   |
| 125 | 0.   | 0.   |
| 126 | 0.   | 0.   |

